Shift - but not too far [working title]

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1 Introduction

Partial height harmonies are instances of so-called *Chain Shifts* where /a/ surfaces as [e] while an underlying /e/ becomes [i] in the very same environment. However, an underlying low vowel /a/ never becomes a high vowel [i]. Thus, the resulting vowel is higher and thus less marked than the underlying low vowel but still lower than the unmarked high vowel. The partial height harmony in Lena Spanish is a well-known instance of this phenomenon, as seen in (1). It becomes clear that the high vowel in the affix *-u* triggers raising of the stem vowel. However, the height harmony displayed in the data can only be seen as a partial harmony with a → e → i but a ↛ i.

(1) Lena Spanish (Hualde 1989; Parkinson 1996)

a → e	gata	getu	'cat'
	santa	sentu	'saint'
e → i	nena	ninu	'child'
	bwena	bwinu	'child'
o → u	bona	bunu	'good'
	koša	kušu	'cripple'

These instances of *Counter-Feeding* have traditionally been considered to be a puzzle for phonological theory: /B/ seems to be too marked to surface as [B] and does thus surface as [C]. However, it is still unmarked enough to realize an underlying /A/ (Neasom 2016). Moreover, McCarthy (1993) and Kirchner (1996) have argued that rule ordering cannot be considered to be an appropriate solution to account for the opacity found in chain shifts since the shifts clearly exhibit two different instances of one and the same raising process.

In section 2, I present and compare five different height harmony systems that have previously been described by Moreton (2010) and Neasom (2016). All languages of the sample exhibit only partial height harmonies such that a shift from /a/ to [i] is banned. However, the languages differ with respect to the quality of the vowel that is derived from an underlying low vowel in a raising-triggering environment.

In this paper, I will approach the puzzles raised by synchronic chain shifts within Containment Theory (van Oostendorp 2006; Revithiadou 2007; Trommer 2011; Trommer &

Zimmermann 2014). In Contaiment Theory, phonological features are never deleted but remain phonetically unrealized. Thus, an underlying /B/ might have a different featural specification than a derived [B]. I will employ this assumption to solve the opacity problems within chain shifts. Moreover, I will show that my analysis differs from previous approaches by Kirchner (1996) and Łubowicz (2012) that fail to account for the harmony system in Bari.

This paper is structured as follows: I will give an overview of different partial height systems in section 2. In section 3, I will present previous approaches to chain shifts, focussing on the influential accounts by Kirchner (1996) and Łubowicz (2012). Before concluding,I will present my analysis of chain shifts implementing Containment Theory in section 4.

2 Overview

In this section, I present five languages that exhibit five different partial height harmony systems. I will summarize the data of each language by listing both the actual shifts and the shifts that could have been expected from the vowel inventory but do not occur in the data.

This is exemplified by the data in Lena Spanish, here repeated in (2). The data exhibit three different shifts in the context of a raising-triggering vowel: 1. Underlying mid vowels become high vowels, /e/ → [i] and /o/ → [u], 2. an underlying low vowel /a/ always surfaces as the mid vowel [e] and never as a high vowel [i].

(2) Lena Spanish (Hualde 1989; Parkinson 1996)

a → e	gata	getu	'cat'
	santa	sentu	'saint'
e → i	nena	ninu	'child'
	bwena	bwinu	'child'
o → u	bona	bunu	'good'
	koša	kušu	'cripple'

Occuring shifts	**Non-occuring shifts**
e → i	a ↛ i
a → e	
o → u	

An example of a partial height harmony with four different vowel heights is illustrated by the Bantu language Nzɛbi, as seen in (3). In this language, the low vowel /a/ becomes the [-ATR] mid vowel ɛ which itself shifts to the [+ATR] mid vowel. However, /a/ never becomes [e] or [i] in Nzɛbi.

(3) Nzɛbi (Bantu, Gabon) (Clements 1991; Parkinson 1996; Moreton 2010; Neasom 2016)

e → i	betə	biti	'carry'
	bexə	bixi	'foretell'
o → u	βoomə	βuumi	'breathe'
	kolən	kulin	'go down'
ɛ → e	sɛbə	sebi	'laugh'
	βɛɛdə	beedi	'give'
ɔ → o	tɔɔdə	toodi	'arrive'
	mɔnə	moni	'see'
a → ɛ	salə	sɛli	'work'
	baadə	bɛɛdi	'be'

Occuring shifts	**Non-occuring shifts**
e → i	a ↛ i
a → ɛ	a ↛ e
o → u	ɛ ↛ i
ɛ → e	
ɔ → o	

The Bantu language Basaá seems to display the opposite picture of a four-height system. In this language, the low vowel /a/ becomes the [+ATR] mid vowel [e]. Schlindwein Schmidt (1996) and Parkinson (1996) have taken this shift as evidence for their assumption that /a/ and /ɛ/ are both of the same vowel height. However, this seems to be a purely theoretical assumption that lacks any further phonological or phonetic evidence. Therefore, it becomes clear that a proper analysis of chain shifts needs to be able to account for the typological variation between Basaá and Nzɛbi.

(4) Basaá (Bantu, Cameroon) (Schlindwein Schmidt 1996; Parkinson 1996; Moreton 2010; Neasom 2016)

e → i	seŋ	siŋ-ha	‘rub, polish’
o → u	top	tub-ha	‘sing’
ɔ → o	yɔŋ	yoŋ-ha	‘take’
ɛ → e	pɛp	peb-ha	‘winnow’
a → e	ɓak	beg-ha	‘weave’

Occuring shifts	**Non-occuring shifts**
e → i	a ↛ i
a → e	a ↛ ɛ
o → u	ɛ ↛ i
ɛ → e	
ɔ → o	

Another four-height system is exhibited by the Niger-Congo language Gbanu. The partial height harmony is similar to the cases in Nzɛbi or Basaá. In Gbanu, however, only [-low] vowels participate in the partial height harmony whereas the low vowel /a/ does not change its height.

(5) Gbanu (Niger-Congo, Central African Republic) (Moñino 1995; Parkinson 1996; Neasom 2016)

e → i	hele	hile	‘cry’
	fe	fie	‘die’
o → u	dolo	dulo	‘forge’
	ko	kuo	‘give birth’
ɛ → e	hɛle	hele	‘tie’
ɔ → o	gɔmo	gomo	‘chop’
a → a	ʔaka	ʔaka	‘ask’

Occuring shifts	**Non-occuring shifts**
e → i	a ↛ i
ɔ → o	a ↛ ɛ
o → u	ɛ ↛ i
ɛ → e	a ↛ e

The Nilo-Saharan language Bari exhibits a partial-height harmony in which only [+ATR] shift to a high vowel whereas [-ATR] vowels do not participate in the harmony.

(6) Bari (Nilo-Saharan, South Sudan) (Yokwe 1987)

e → i	rém	rímún	‘spear’
o → u	dók	dúkún	‘wrap’
ɛ → ɛ	dɛ́r	dɛ́rɛ́n	‘cook’
ɔ → ɔ	mɔ́k	mɔ̀ktɔ̀n	‘catch’

Occuring shifts	Non-occuring shifts
e → i	ɛ ↛ i
o → u	ɛ ↛ e

The findings of this section are summarized in Table 1. It is clear that all vowel harmonies are only **partial** harmonies as the shift from /a/ to [i] is banned in all five languages. Moreover, [+ATR] mid vowels become high vowels in all languages. The languages differ, however, in the realization of underlying low vowels. In section 3, I will show that my analysis overcomes the challenge of the typological variation among the different partial height systems in contrast to previous analysis of Chain Shifts by Kirchner (1996) and Łubowicz (2012) who fail to derive the harmony patterns in Bari.

Shifts	Languages
a → e	Lena Spanish, Basaá
e → i	Lena Spanish, Nzɛbi, Basaá, Gbanu, Bari
o → u	Lena Spanish, Nzɛbi, Basaá, Gbanu, Bari
a → ɛ	Nzɛbi
ɛ → e	Nzɛbi, Basaá, Gbanu
ɔ → o	Nzɛbi, Basaá, Gbanu
a ↛ i	Lena Spanish, Nzɛbi, Basaá, Gbanu, Bari
a ↛ e	Nzɛbi, Gbanu
a ↛ ɛ	Basaá, Gbanu
ɛ ↛ i	Nzɛbi, Basaá, Gbanu, Bari
ɛ ↛ e	Bari

Table 1: Overview on partial height harmonies

3 Previous approaches

3.1 Local conjunction by Kirchner (1996)

As shown in the previous section, chain shifts are an instance of *Counter-Feeding*. It might therefore seem intuitive to account for the opacity problem by rule-ordering. Specifically, the shift from /e/ to [i] would apply earlier than the shift from /a/ to [e]

thus preventing /a/ from shifting to [i]. However, it is generally assumed that rule-ordering is not a suitable approach for partial height harmonies as it seems that both rules are actually two instances of one and the same phonological process since they occur in the same context (McCarthy 1993; Kirchner 1996; Łubowicz 2012).

1. e → i
2. a → e
3. a ↛ i

Therefore, Kirchner (1996) suggests to face the opacity problem within Parallel OT using Local Conjunction (Smolensky 1993). In local conjunction, a new constraint is formed by conjoining to other constraints which means that the constraint is violated if and only if both of its parts are violated. Thus, Kirchner (1996) can derive the observation that raising in Chain Shifts happens stepwise as raising /a/ to [i] in one fell swoop would violate two faithfulness constraints and therefore also the top-ranked conjoined constraint. Concretely, he assumes a raising-triggering constraint (RAISING) which needs to be higher-ranked than the three markedness constraints (PARSE_{F}) in order to explain the shift from /e/ to [i]. Additionally, the two faithfulness constraints appear as a locally conjoined constraint as the top-ranked constraint which is fatally violated by the high vowel [i], as seen in the tableau in (7).

(7) Chain Shifts derived by Local Conjunction (simplified, following Kirchner (1996))

/a/	$\text{PARSE}_{\text{high}}$ & $\text{PARSE}_{\text{low}}$	RAISING	$\text{PARSE}_{\text{low}}$	$\text{PARSE}_{\text{high}}$	$\text{PARSE}_{\text{ATR}}$
a. a		∗∗∗!			
b. ☞ e		∗	∗		∗
c. i	∗!		∗	∗	∗

As local conjunction has been claimed to be a very powerful and potentially over-generalizing tool, Kirchner (1996) restricts it by allowing only a conjunction of two faithfullness constraints that make reference to the same dimension, specifically vowel height. Even though Kirchner (1996) can perfectly derive easy chain shift, I will show in section 4 that he faces problem with the chain shift in Nilo-Saharan language Bari.

3.2 PRESERVE CONTRAST by Łubowicz (2012)

While Kirchner (1996) uses local conjunction to prevent a shift in one fell swoop, the account by Łubowicz (2012) bases on a constraint named PRESERVE CONTRAST (PC). Concretely, PRESERVE CONTRAST ensures that phonological distinctions in the input are preserved in the output. In contrast to Standard Parallel OT, GEN does not generate single phonological forms but whole phonological systems. Specifically, PRESERVE CONTRAST is violated if a distinction between two phonological forms has been neutralized in the output. This constraint is used to prevent /a/ from shifting to [i]: In the input, there is a phonemic distinction between /a/ and /e/. If both vowels would surface as [i], this distinction would be lost leading to a fatal violation of $PC_{a\text{-}e}$.

		$PC_{a\text{-}e}$	SHIFT	$PC_{e\text{-}i}$
a. ☞	a → e, e → i		*	*
b.	a → a, e → e		**!	
c.	a → i, e → i	*!		*

Even though her account might seem theoretically controversial, she succeeds in deriving a large number of Chain Shifts and the typological variation among them, Łubowicz (2012) needs additional assumptions to derive the Chain Shift in Bari as I will point in section 4.

4 Chain Shifts in Containment Theory

Coloured Containment Theory (van Oostendorp 2006; Revithiadou 2007; Trommer 2011; Trommer & Zimmermann 2014) has been argued to be able to account for different instances of phonological opacity. In Containment Theory, phonological process never lead to the deletion of features. Rather, they make phonological features invisible for phonetics but remain in the phonological structure. Due to this assumptions, an underlying segment may have a different featural specification than a derived segment. I follow Trommer (2011) by assuming three kinds of association lines that reveal the phonological structure of a segment:

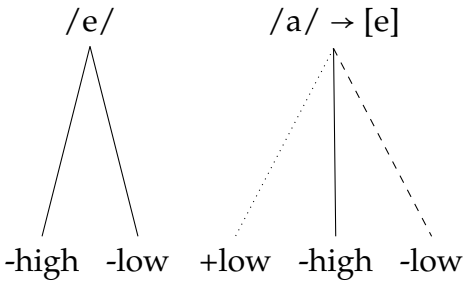
1. Elements that are **underlying** and **phonetically visible** are represented by a straight line

2. Elements that are **underlying** and **phonetically invisible** are represented by a dotted line

3. Elements that are **not underlying** and **phonetically visible** are represented by a dashed line

These assumptions may be exploited to solve to the counter-feeding problem posed by partial height harmonies as they automatically lead to the assumption that an underlying vowel like /e/ has different features than a vowel [e] that is derived by vowel raising from /a/ as the [+low] feature of a cannot be deleted. This idea was already mentioned by Kirchner (1996) who mentions that '*[a]n alternative approach is to build the stepwise condition into the raising constraint itself, by allowing the constraint to refer to the underlying height of the vowel.*' (Kirchner 1996, p. 6)

(8) Feature structures of underlying and derived mid vowel *e*



Moreover, I assume that there are two versions of constraints following the *Cloning Hypothesis* by Trommer (2011)[1]:

1. **P-Constraints** only refer to the phonological features that are phonetically visible.

2. **I-Constraints** refer to all features.

The core idea of my analysis is that an input A surfaces as B and not as C due to phonetic markedness constraints. Specifically, I assume that the harmonies described in section 2 are triggered by a phonological element which is specified as [+high, -low, +ATR] (Kirchner 1996). This element may surface as a high vowel or remain covert as a floating feature. Crucially, the languages presented in 2 are only partial harmonies since low vowels can never become high vowels due to a constraint *[+low,+high]$_I$ that has access to **all** phonological features. **Thus, the illicit combination of the [+low] feature of the underlying sound /a/ and the [+high] feature of the resulting sound [i] make the shift from /a/ to [i] impossible**. Abstractly, the approach can be modelled in OT in the following two tableaux. The first tableau shows that the harmony

[1] In this paper, I will mark P-constraints with an indexed $_P$ and I-constraints with an indexed $_I$.

constraints, which only have access to the phonetically visible features must be higher-ranked than the faithfulness constraints. However, this ranking would predict the wrong optimal candidate for an underlying /a/ as seen in (10). Therefore, I assume that there is a constraint *[+low,+high]$_I$ that rules out [i] as the optimal candidate. It is crucial that this constraint is not stipulative but builds on a strong phonological basis. Concretely, Hall (2000) notes that it is phonetically impossible for a vowel to be [+low,+high] as it is articulatorily impossible to lift and lower the dorsum simultaneously.

(9) Abstract chain shift: /e/ → [i]

/e/	*[+low,+high]$_I$	Harmony$_{highP}$	Harmony$_{lowP}$	Faith$_{highI}$	Faith$_{lowI}$
a. e		*!			
b. ☞ i				*	

(10) Abstract chain shift: /a/ → [e]

/a/	*[+low,+high]$_I$	Harmony$_{highP}$	Harmony$_{lowP}$	Faith$_{highI}$	Faith$_{lowI}$
a. a		*!	*		
b. ☞ e			*		*
c. i	*!			*	*

The tableaux could account for the partial height harmony in languages with three different vowel heights, such as Lena Spanish, as seen in 2. For languages with five different vowel heights, however, a closer look to the distribution of [±ATR] is needed. It is a well-known and wide-spread assumption that low vowels tend to be unmarked if [-ATR] and high vowels are unmarked if they are [+ATR]. Evidence for this assumptions can be taken from vowel inventories (Casali 2014): Some languages like Akan lack [+low,+ATR] vowels while Yoruba and Kinande lack [+high,-ATR] segments. There is, however, neither a language with only [+high,-ATR] vowels lacking [+high,+ATR] sounds nor a language with [+low,+ATR] vowels lacking [+low,-ATR] sounds. Archangeli & Pulleyblank (1994) raises further evidence by showing

that [+ATR] harmony in Pulaar does not spread onto [+low] segments. However, the markedness of [±ATR] mid vowels is an ongoing debate. Kaye et al. (1985) and Bakovic (2000) claim that all non-low [+ATR] vowels are marked while Archangeli & Pulleyblank (1994) and Calabrese (1995) note that all non-high [-ATR] vowels are marked. While the status of mid vowels remains unclear, I conclude that there is strong evidence for the following two constraints:

1. *[+low,+ATR]$_I$ to avoid low [+ATR] vowels
2. *[+high, -ATR]$_I$ to avoid high [-ATR] vowels

The constraints mentioned above differ from the first constraint *[+low,+high]$_I$ in that they do not adress articulatorily impossible but marked segments. Thus, they are inherently lower ranked than *[+low,+high]$_I$.

In the following three tableaux, I will derive the partial height harmony in Nzɛbi. The tableau in (11) shows that [ɛ] becomes the optimal candidate as the high-ranked markedness constraint *[+low,+ATR]$_I$ is violated by the high vowel [i]. If the tableaux (12) and (13) are compared, it becomes clear how the markedness constraint work in Containment logic. In (12), /ɛ/ cannot shift to [i] as its [-ATR] feature is still present in the structure which leads to a violation of the high-ranked *[+high, -ATR]$_I$ constraint. If the underlying vowel is /e/ and thus [+ATR], the markedness constraint is not violated, as seen in (13).

(11) Nzɛbi, a → ɛ

/a/ - [+high, -low, +ATR]		*[+low,+high]$_I$	*[+low,+ATR]$_I$	*[+high, -ATR]$_I$	Harmony$_{highP}$	Harmony$_{lowP}$	Harmony$_{ATRP}$	Faith$_{highI}$	Faith$_{lowI}$	Faith$_{ATRI}$
a.	a				*	*!	*			
b. ☞	ɛ				*		*		*	
c.	e		*!		*				*	*
d.	i	*!	*	*				*	*	*
e.	ɪ	*!		*			*	*	*	

(12) Nzɛbi, ɛ → e

/ɛ/ - [+high, -low, +ATR]	*[+low,+high]$_I$	*[+low,+ATR]$_I$	*[+high, -ATR]$_I$	Harmony$_{highP}$	Harmony$_{lowP}$	Harmony$_{ATRP}$	Faith$_{highI}$	Faith$_{lowI}$	Faith$_{ATRI}$
a. ɛ				*		*!			
b. ☞ e				*					*
c. i			*!				*		*
d. ɪ			*!			*	*		

(13) Nzɛbi , e → i

/e/ - [+high, -low, +ATR]	*[+low,+high]$_I$	*[+low,+ATR]$_I$	*[+high, -ATR]$_I$	Harmony$_{highP}$	Harmony$_{lowP}$	Harmony$_{ATRP}$	Faith$_{highI}$	Faith$_{lowI}$	Faith$_{ATRI}$
a. ɛ				*!		*!			*
b. e				*!					
c. ☞ i							*		
d. ɪ			*!			*	*		*

The partial height harmony in Basaá is also a four-height harmony. In contrast to Nzɛbi, however, /a/ shifts to [e] in Basaá. In contrast to Nzɛbi, *[+low,+ATR]$_I$ is very low-ranked and thus not part of the tableaux which makes [e] become optimal.

(14) Basaá, a → e

/a/ - [+high,-low, +ATR]	*[+low,+high]$_I$	*[+high, -ATR]$_I$	Harmony$_{highP}$	Harmony$_{lowP}$	Harmony$_{ATRP}$	Faith$_{highI}$	Faith$_{lowI}$	Faith$_{ATRI}$
a. a			*	*!	*!			
b. ɛ			*		*!		*	
c. ☞ e			*				*	*
d. i	*!	*				*	*	*
e. ɪ	*!	*			*	*	*	

(15) Basaá, ɛ → e

/ɛ/ - [+high, -low, +ATR]	*[+low,+high]$_I$	*[+high, -ATR]$_I$	Harmony$_{highP}$	Harmony$_{lowP}$	Harmony$_{ATRP}$	Faith$_{highI}$	Faith$_{lowI}$	Faith$_{ATRI}$
a. ɛ			*		*!			
b. ☞ e			*					*
c. i		*!				*		*
d. ɪ		*!				*		

(16) Basaá, e → i

/e/ - [+high, -low, +ATR]	*[+low,+high]$_I$	*[+high, -ATR]$_I$	Harmony$_{highP}$	Harmony$_{lowP}$	Harmony$_{ATRP}$	Faith$_{highI}$	Faith$_{lowI}$	Faith$_{ATRI}$
a. ɛ			*!		*!			*
b. e			*!					
c. ☞ i						*		
d. ɪ		*!				*		*

Recall that the partial height harmony in Gbanu patterns with the harmonies in Nzɛbi and Basaá except that low vowels do not participate. This difference results from the high-ranked Faith$_{lowI}$ constraint, as seen in the following tableaux.

(17) Gbanu, a → a

/a/ - [+high, -low, +ATR]	*[+low,+high]$_I$	Faith$_{lowI}$	*[+high, -ATR]$_I$	Harmony$_{highP}$	Harmony$_{lowP}$	Harmony$_{ATRP}$	Faith$_{highI}$	Faith$_{ATRI}$
a. ☞ a				*	*	*		
b. ɛ		*!		*		*		
c. e		*!		*				*
d. i	*!		*			*	*	*
e. ɪ	*!		*			*	*	

(18) Gbanu, ɛ → e

/ɛ/ - [+high, -low, +ATR]		*[+low,+high]$_I$	Faith$_{lowI}$	*[+high, -ATR]$_I$	Harmony$_{highP}$	Harmony$_{lowP}$	Harmony$_{ATRP}$	Faith$_{highI}$	Faith$_{ATRI}$
a.	ɛ				*		*!		
b. ☞	e				*				*
c.	i			*!				*	*
d.	ɪ			*!			*	*	

(19) Gbanu, e → i

/e/ - [+high, -low, +ATR]		*[+low,+high]$_I$	Faith$_{lowI}$	*[+high, -ATR]$_I$	Harmony$_{highP}$	Harmony$_{lowP}$	Harmony$_{ATRP}$	Faith$_{highI}$	Faith$_{ATRI}$
a.	ɛ				*!		*!		*
b.	e				*!				
c. ☞	i							*	
d.	ɪ			*!			*	*	*

In Bari, only [+ATR] vowels participate in the harmony. This is derived by the high-ranked Faith$_{ATRI}$ constraint in addition to the markedness constraint *[+high, -ATR]$_I$ which prevents the [+high, -ATR] vowel ʊ from becoming optimal.

(20) Bari, ɔ → ɔ

/ɔ/ - [+high, -low, +ATR]		Faith$_{ATRI}$	*[+high, -ATR]$_I$	Harmony$_{highP}$	Harmony$_{lowP}$	Harmony$_{ATRP}$	Faith$_{highI}$	Faith$_{lowI}$
a. ☞	ɔ			*		*		
b.	o	*!		*				
c.	ʊ		*!			*	*	
d.	u	*!	*				*	

(21) Bari, o → u

/o/ - [+high, -low, +ATR]	$\text{Faith}_{\text{ATRI}}$	*[+high, -ATR]$_{\text{I}}$	$\text{Harmony}_{\text{highP}}$	$\text{Harmony}_{\text{lowP}}$	$\text{Harmony}_{\text{ATRP}}$	$\text{Faith}_{\text{highI}}$	$\text{Faith}_{\text{lowI}}$
a. ɔ	*!		*		*		
b. o			*!				
c. ʊ	*!	*			*	*	
d. ☞ u						*	

In sum, we end up with the following list of constraints that are needed to account for the data of the five different languages presented in section 2:

(22)

*[+LOW,+HIGH]$_{\text{I}}$	Avoid [+low, +high] vowels.
*[+LOW,+ATR]$_{\text{I}}$	Avoid [+low, +ATR] vowels.
*[+HIGH, -ATR]$_{\text{I}}$	Avoid [+high, -ATR] vowels.
FAITH$_{\text{HIGHI}}$	Do not make features of [±high] phonetically invisible.
FAITH$_{\text{LOWI}}$	Do not make features of [±low] phonetically invisible.
FAITH$_{\text{ATRI}}$	Do not make features of [±ATR] phonetically invisible.
HARMONY$_{\text{HIGHP}}$	Avoid contradictory features of [±high].
HARMONY$_{\text{LOWP}}$	Avoid contradictory features of [±low].
HARMONY$_{\text{ATRP}}$	Avoid contradictory features of [±ATR].

It is crucial that both constraint conjunction by Kirchner (1996) and PRESERVE CONTRAST by Łubowicz (2012) face problems with the partial height harmony in Bari. Recall that in Bari, only [+ATR] vowels participate in the harmony, such that /o/ → [u] with /ɔ/ ↛ [ɔ]. Crucially, RAISING needs to outrank the faithfulness constraints in order to make /o/ shift to [u]. However, local conjunction predicts that the [-ATR] vowels should shift to its [+ATR] variants, as seen in the following tableau:

(23) Bari, /ɔ/, wrong winner predicted by Local conjunction

/ɔ/	PARSE$_{high}$ & PARSE$_{ATR}$	RAISING	PARSE$_{high}$	PARSE$_{low}$	PARSE$_{ATR}$
a. ☛ ɔ		∗∗!			
b. ☞ o		∗			∗
c. ʊ		∗	∗!		
d. u	∗!		∗		∗

Moreover, letting PARSE$_{ATR}$ outrank the harmony-triggering constraint does not help either since this ranking predicts that /ɔ/ should shift to its [+high, -ATR] variant, which is part of the Bari vowel inventory but not the correct surface form.

(24) Bari, /ɔ/, wrong winner predicted by re-ranking

/ɔ	PARSE$_{ATR}$	RAISING	PARSE$_{high}$	PARSE$_{low}$
a. ☛ ɔ		∗∗!		
b. o	∗!	∗		
c. ☞ ʊ		∗	∗	
d. u	∗!		∗	

Essentially, the approach by Łubowicz (2012) using PRESERVE CONTRAST predicts that /ɔ/ should shift as the harmony-triggering constraint forces the input to be maximally raised.

	PC$_{ɔ\text{-}o}$	SHIFT	PC$_{o\text{-}u}$
a. ☛ ɔ → ɔ, o → u		∗ ∗!	∗
b. ☞ ɔ → o, o → u		∗	∗

In this section, I have shown that Containment Theory may not only exploited to account for typologically different types of Chain Shifts but also that Containment Theory makes the better predictions with respect to the the Chain Shift in The Nilo-Saharan language Bari.

5 Conclusion

In this paper, I have analysed the opacity problems posed by partial height harmonies within Containment Theory. Concretely, I have shown that phonetic markedness constraint that can make reference to both input and output features of a segment prevent shifts from /a/ to [i] as this would result in an illicit combination of features. I have shown in 4 that my analysis can easily account for different types of height harmonies while previous analyses face problems with the vowel harmony system in Bari.

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